(NASA-CR-119293) VISIBILITY OF ORBITAL ASSEMBLY FROM CSM DURING RENDEZVOUS (Bellcomm, Inc.) 7 p

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date: June 28, 1971

to: Distribution

from: D. J. Belz

subject: Visibility of Orbital Assembly from CSM During Rendezvous - Case 610

## ABSTRACT

The visibility of the Orbital Assembly (OA) from a CSM during rendezvous is analyzed. It is shown that light reflected from the OA may not be detectable when the CSM is over the earth's sunlit hemisphere unless the earth is kept out of the observer's field-of-view. However, if that condition is met the OA will be visible whenever it is in direct sunlight during the last two orbital revolutions of the rendezvous. It was found that for a representative SL-4 mission, the OA's reflected light will give it the appearance of a third magnitude star or better whenever it is in direct sunlight beyond 4.2 hours GET. Beyond 4.6 hours GET, the OA will appear brighter than a first magnitude star whenever it is in direct sunlight, except for a brief period at approximately 5.7 hours GET.

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MEMORANDUM FOR FILE

Visual sightings of the Orbital Assembly through the Command Module sextant during a Skylab rendezvous can provide navigational information that will reduce uncertainties in the relative position of the two vehicles as calculated within the CM computer. Visibility of the OA will be determined primarily by its distance from the CSM, the intensity of light radiated toward the CSM, the luminous background against which the OA will be viewed, the visual sensitivity of the crewman-observer, and the effects of sextant optics.

An analysis of visibility thresholds based on brightness discrimination was undertaken using techniques previously described in Reference 1. For an observer with normal vision, the dominant effects governing the visibility of the OA at a given mission time are the background luminance against which it will be viewed and the level of light adaptation of the observer's eyes.

The CSM's altitude during rendezvous will be lower than that of the OA. Therefore, the OA will always appear against a deep-space background. However, if the sunlit earth also appears within the observer's field-of-view, the OA's visibility will be reduced due to a reduction in the observer's dark adaptation. A rigorous analysis of OA visibility under such conditions is not possible. A conservative bound on the problem can, however, be obtained by treating the actual background consisting of the earth and deep space as if its luminance were entirely that of the sunlit earth. During periods when the CSM is over the dark side of the earth, the corresponding bound is based on the luminance of the earth resulting only from reflected starlight, nightglow, and moonlight.

The Orbital Assembly reflects direct sunlight and sunlight previously reflected from the earth. In addition, there are redundant acquisition lights mounted on the MDA. A companion study reported in Reference 2 adapted computer programs originally designed for thermal analyses to permit the determination of light reflected from the OA as a function of time. An M=5 SL-4 rendezvous, based on a November 9, 1972 SL-1 launch date was used as an example. Only data for the earth-oriented OA rendezvous attitude were presented. Figure 1 of this memorandum reproduces the data of Figure 8 in Reference 2 and includes three detection thresholds based on brightness discrimination against backgrounds corresponding to the sunlit earth, night-time earth, and deep space. Also shown for reference are a scale of stellar magnitudes and times of rendezvous propulsive maneuvers. Maneuver times and times of passage over the dark and light hemispheres of the earth were calculated by R. C. Purkey using the NAGS (Navigation and Guidance Simulator) computer program.

The data shown in Figure 1 indicate that:

1. Reflected light from the OA may not be visible to the unaided eye when the CSM is over the earth's sunlit hemisphere unless the earth is kept out of the observer's field-of-view.

2. A properly dark-adapted observer will be able to see the OA against deep-space background provided the OA's illuminance corresponds to the seventh stellar magnitude or brighter. This will occur whenever the OA is in direct sunlight during the last two orbits of the rendezvous.

3. Beyond 4.2 hours from CSM launch, the OA's reflected light will give it the appearance of a 3rd magnitude star or better, whenever the OA is in direct sunlight.

4. Beyond 4.6 hours into the CSM's flight, the OA will appear brighter than a

first magnitude star whenever it is in direct sunlight, except for a brief period at approximately 5.7 hours Ground Elapsed Time.

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1025-DJB-li

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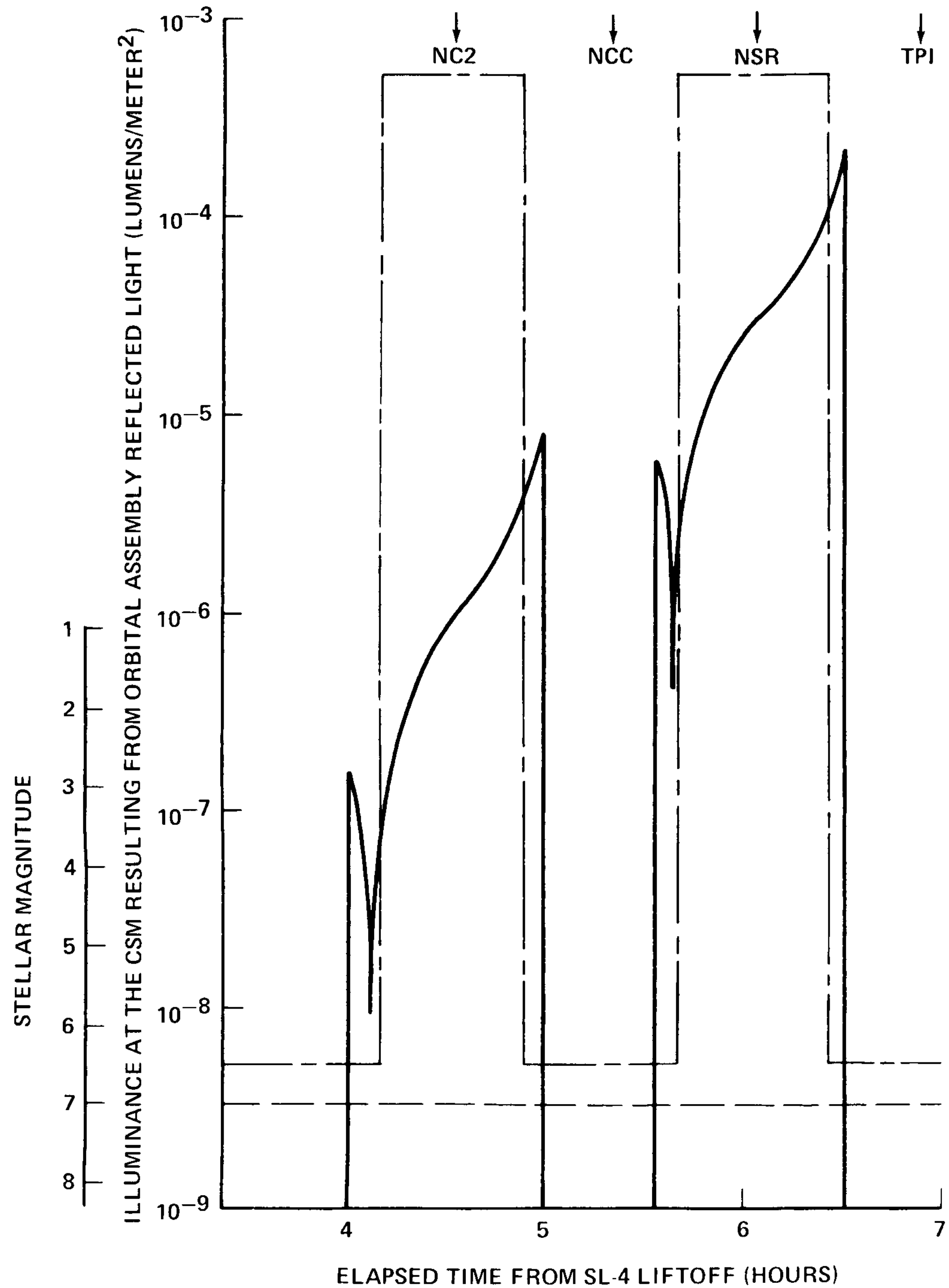
Attachment

## References


1. D. J. Belz, "Optical Beacons for Acquisition and Tracking of S191 Targets During Night-Side Passes", Technical Memorandum 71-1025-2, April 22, 1971.

2. A. W. Zachar, "Skylab Saturn Workshop Diffusively Reflected Solar Light at the CSM During Rendezvous", Memorandum for File (In Preparation).




NOTES:

1) — — — DENOTES POINT SOURCE VISIBILITY THRESHOLD AGAINST DEEP-SPACE BACKGROUND

2) ——— — DENOTES UPPER BOUND ON VISIBILITY THRESHOLD WITH CLOUDLESS EARTH IN OBSERVER'S FIELD OF VIEW

3) ↓ DENOTES INITIATION OF RENDEZVOUS MANEUVERS

4) CURVES ARE BASED ON AN M=5 RENDEZVOUS, SL-1 LAUNCH DATE OF NOVEMBER 9, 1972

FIGURE 1 - COMPARISON OF VISIBILITY BOUNDS AND LIGHT REFLECTED FROM THE ORBITAL WORKSHOP DURING A REPRESENTATIVE SL-4 RENDEZVOUS

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